5. Total Maximum Daily Loads

To assure water quality standards are met, a TMDL prescribes an upper limit for discharge of a pollutant from all sources. It allocates this upper limit, or load capacity (LC), among the various sources of the pollutant. Pollutant sources fall into two broad classes: point sources, each of which receives a wasteload allocation (WLA); and nonpoint sources, which receive a load allocation (LA). Subbasin point sources discharge into Snake River or the reservoir; there are no point source dischargers in Bannock Creek or McTucker Creek watersheds.

Natural background (NB), when present, is considered part of the load allocation, but is often identified individually because it represents part of the load not subject to control. Estimates of NB can be difficult in highly modified waterbodies, such as those found in American Falls Subbasin. Sometimes, natural background levels of reference streams (similar streams with little human impact) can be used as a surrogate for the stream of interest. Unfortunately, finding reference streams in southern Idaho is difficult, especially for a stream the size of Snake River. For American Falls Subbasin TMDLs, it was assumed that natural background levels are included in target concentrations chosen for nutrients and sediment.

Because of uncertainties regarding quantification of loads and the relation of specific loads to attainment of water quality standards, rules regarding TMDLs (Water quality planning and management, 40 CFR 130) require a margin of safety (MOS) be a part of the TMDL. Practically, both NB and MOS are reductions in the load capacity that would otherwise be available for allocation to human-caused sources of pollutants.

The TMDL can be summarized symbolically as the equation: LC = MOS + NB + LA + WLA = TMDL. The equation is written in this order because it represents the logical order in which a loading analysis is conducted. First LC is determined, and then LC is broken down into its components: the necessary MOS is determined and subtracted; then NB, if relevant, is quantified and subtracted; and then the remainder is allocated among pollutant sources. When the breakdown and allocation is completed, a TMDL results, which must equal LC.

There are several additional aspects to the loading analysis including quantification of pollutant loading by source and consideration of critical conditions. Quantification of current pollutant loads by source allows for specification of load reductions as percentages from current conditions, considers equities in load reduction responsibility, and is necessary in order for pollutant trading to occur. A requirement of the loading analysis is that LC be based on critical conditions – the conditions when water quality standards are most likely to be violated. Critical conditions are expected to recur on a regular basis such as calculating flows based on 7Q10 (the lowest streamflow for 7 consecutive days that occurs on average once every 10 years). If protective under critical conditions, a TMDL will be more protective under other conditions. Because both LC and pollutant source loads vary, sometimes independently, determination of critical conditions can become fairly complicated.

A load is fundamentally a quantity of a pollutant discharged over some period, and is the product of concentration and flow. Due to the diverse nature of various pollutants, and the difficulty of strictly dealing with loads, federal rules allow for “other appropriate measures” to be used when necessary. These "other measures" must still be quantifiable, and relate to water quality standards, but they allow flexibility to deal with pollutant loading in more practical and tangible ways. The rules also recognize the particular difficulty of quantifying nonpoint loads, allowing "gross allotment" as a load allocation where available data or appropriate predictive techniques limit more accurate estimates. For pollutants whose effects are long term, such as sediment and nutrients, EPA allows for seasonal or annual loads.

The goal of TMDLs established in this report is to restore "full support of designated beneficial uses" of water quality limited segments in American Falls Subbasin (Idaho Code 39.3611, 3615). As detailed in Section 2, these TMDLs are necessary to restore and maintain coldwater aquatic life, salmonid spawning, and contact recreation beneficial uses designated in Idaho Water Quality Standards (see Section 2.2) for those 303(d)-listed waterbodies in the subbasin. Nutrients and sediment are defined under state water quality standards by narrative, rather than numeric, criteria. For these pollutants, DEQ and the Shoshone-Bannock Tribes have collaborated to derive surrogates or numeric translators as instream water quality targets to establish TMDLs. These surrogates relate to DEQ's goal of supporting beneficial uses by establishing a threshold above which it appears that concentrations or loads of nutrients and sediment have a recognizable impact on aquatic life. Surrogates also create the basis for DEQ and Shoshone-Bannock Tribes to aim their water quality management strategies at "a quantifiable measure" rather than a qualitative measure as is subjectively defined in existing narrative criteria. Surrogate instream water quality targets outlined below for nutrients and sediment allow the flexibility necessary to address characteristics of both nonpoint and point sources of pollutants in more practical and tangible ways.

The following sections of this report present TMDLs required to address excessive pollutant loads in American Falls Subbasin. TMDLs addressing nutrients (both nitrogen and phosphorus) were written for Snake River, Bannock Creek, and various tributaries, springs, and drains discharging to American Falls Reservoir. Sediment TMDLs were prepared for Snake River, Bannock Creek, West Fork Bannock Creek, Moonshine Creek, Rattlesnake Creek, McTucker Creek, and Sunbeam Creek. Wasteload allocations were developed for subbasin point sources. Problems not addressed in this report include flow alteration in Snake River and American Falls Reservoir, and bacteria in Bannock Creek. Algal densities and the resulting decay exacerbate dissolved oxygen problems in American Falls Reservoir, and it is assumed a reduction in chlorophyll *a* will lead to support of appropriate dissolved oxygen levels in the reservoir.

5.1 Instream Water Quality Targets

End points are set with the idea that their attainment will support beneficial uses. To achieve beneficial use support, end points include both water quality standards and targets. Standards are codified in DEQ's Water Quality Standards and Wastewater Treatment Rules (58.01.02).

Targets are recommended for narrative standards, those standards that do not specify a numeric value necessary to achieve beneficial use support. Targets are proposed that, if achieved, have a great likelihood of leading to support of beneficial uses. The ultimate goal is to support beneficial uses, not to meet target criteria. Should reductions in pollutant loading result in achievement of beneficial uses prior to meeting the recommended target, then there may be no need to reduce loads further to meet the target (except to allow for a margin of safety). Equally, if the target were to be met and beneficial uses not supported, the chosen target would be reexamined and possibly made more stringent.

Design Conditions/Seasonal Variation

Critical periods are not proposed for dissolved oxygen, bacteria, or sediment. Water quality standards for dissolved oxygen and bacteria do not account for seasonality. Effects of sediment in aquatic systems are not limited to a particular time of year, whether they are water column effects from abrasion or decreasing visibility, or sediment accumulation filling interstitial substrate spaces, degrading the area for salmonid spawning use.

For the Bannock Creek watershed analysis, to qualify the seasonal and annual variability and critical timing of sediment loading, climate and hydrology must be considered. This sediment analysis characterizes sediment loads using average annual rates determined from empirical characteristics developed over time within the influence of peak and base flow conditions. While deriving these estimates, it is difficult to account for seasonal and annual variation within a particular time frame; however, seasonal and annual variation is accounted for over the longer time frame under which observed conditions have developed. Annual erosion and sediment delivery are primarily a function of climate where wet water years typically produce highest sediment loads. Additionally, annual average sediment load is not distributed equally throughout the year. Erosion typically occurs during a few critical months. For example, in Bannock Creek watershed, most stream bank erosion occurs during spring runoff while most hillslope erosion occurs during summer thunderstorms and spring runoff. Given the variability of sediment loading, these TMDLs are expressed as annual average loads.

The critical period for nutrients affecting beneficial uses generally is the warmer months of summer and early fall. Nutrients promote growth of aquatic vegetation, which usually is at highest density in late summer - a time of high recreational use. When vegetative matter such as algae dies, it sinks to the bottom where microbial action uses oxygen to breakdown organic matter. Warmer water temperatures occur in summer, and because saturation levels of gases decline as temperature increases, decreased concentrations of dissolved oxygen result. These conditions stress aquatic biota when oxygen levels are low, and respiration of dense aquatic vegetation pushes dissolved oxygen concentrations lower. The target concentration for chlorophyll *a* in American Falls Reservoir will be an average concentration for July and August – times of greatest concern for high densities of algae and dissolved oxygen problems.

The extent to which either nitrogen or phosphorus exceeds seasonal load capacity is unknown. The tendency for the uptake of phosphorus as phosphates by sediment creates the potential for phosphorus availability throughout the growing season regardless of time of input. Phosphorus in sediment is directly available for uptake by rooted aquatic vegetation, and becomes available to algae or surface vegetative growth when phosphorus adsorbed to sediment is released into the water column under anoxic (no oxygen) conditions. Conversely, nitrogen tends to remain dissolved and will “flow through” in lotic, or stream, systems. Lentic waters (e.g., lakes and reservoirs) act as sinks for nutrients, especially phosphorus, increasing the available time for uptake by aquatic vegetation. Thus, phosphorus or nitrogen that entered a stream in February could be bioavailable to aquatic vegetation in a reservoir in July when conditions are conducive to algal or macrophytic growth. Due to concern about American Falls Reservoir, which is on the 303(d) list for nutrients, no allowance for seasonal variation in nutrient loading is made.

Loads are calculated on a mass per unit time basis. An actual total maximum daily load is too refined (i.e., daily basis) to be practical for nonpoint source pollutants. At the other extreme, a total maximum annual load may mask short, intense periods (i.e., spring runoff or episodic storm events), when loads are excessive and need to be controlled, followed by longer periods of relative inactivity. Therefore, some period between daily and annual loads is needed.

For American Falls Subbasin, mass per unit time varied by pollutant. Bacteria loads were based on a geometric mean of five samples collected over a 30-day period per state water quality standards. Sediment loads were based on a two-week average concentration, not to exceed the annual load allocation. Nutrient loads were allocated on an annual basis, not to exceed in any one month the prorated annual load allocation.

Target Selection

Selection of appropriate end points to support beneficial uses in American Falls Subbasin incorporated current water quality standards for bacteria and dissolved oxygen, or targets for nutrients and sediment. Selected targets were chosen based on suggested literature values (e.g., EPA-recommended criteria) or values used in TMDLs written for similar waterbodies.

Flow Alteration

American Falls Reservoir and Snake River are listed for flow alteration. Although both are impaired due to a lack of flow, EPA does not believe that flow (or lack of flow) is a pollutant as defined by CWA Section 502(6). Since TMDLs are not required for waterbodies impaired by pollution but not pollutants, a TMDL for flow alteration has not been established for either American Falls Reservoir or Snake River.

Dissolved Oxygen

Dissolved oxygen is listed as a problem in American Falls Reservoir and Snake River from Ferry Butte to the Bingham-Bonneville county line. Dissolved oxygen standards vary between streams and lakes or reservoirs (IDAPA 58.01.02.250.02.a). To support coldwater aquatic life in streams, dissolved oxygen levels must exceed 6 mg/L at all times. For lakes and reservoirs, the 6 mg/L DO standard also applies to the top 80% of water depth where depths are 35 m or less (e.g., American Falls Reservoir). In stratified lakes and reservoirs, the standard applies to the top layers of water (epilimnion and metalimnion), but not to the bottom layer (hypolimnion).

Bacteria

Only Bannock Creek has any indication of possible impairment from bacteria. State water quality standards for secondary contact recreation require levels of *E. coli* not exceed a 30-day geometric mean (based on 5 samples) of 126 organisms/100 ml of water (IDAPA 58.01.02.251.02.b).

Nutrients

American Falls Reservoir, Snake River, and Bannock Creek are listed for impairment of beneficial uses due to nutrients. As the limiting nutrient is unknown, targets were set for both phosphorus and nitrogen.

EPA has issued several documents providing guidance on nutrients, especially phosphorus, in aquatic systems. The EPA (1986) "Gold Book" recommended for streams that do not discharge into lakes or reservoirs, a target of 0.1 mg/L of total phosphorus. For those reaches that discharge into a lake or reservoir, the Gold Book suggests a threshold of total phosphorus of 0.05 mg/L. In EPA (2000) Criteria, total phosphorus in reference sites, based on the 25th percentile, ranged from 0.010 to 0.055 mg/L. The recommended target of 0.05 mg/L for stream reaches represents a 9% reduction from the upper end of the reference site range. It also is in line with the "Gold Book" recommendation of total phosphorus not exceeding 0.05 mg/L for reaches discharging into lakes or reservoir. Note: this total phosphorus target is a change from that recommended in the original TMDL for the Portneuf River (DEQ 2001b) and will be reflected in the TMDL when it is revisited in 2004.

Although phosphorus is most likely the limiting nutrient in American Falls Reservoir, enough uncertainty exists that a nitrogen target is also proposed. Except for Portneuf River, the total nitrogen target is set at 0.85 mg/L. This value represents the upper end of the range, 0.22-0.90 mg/L, of total nitrogen found in the upper 25th percentile of streams reviewed in EPA (2000) Criteria. Total inorganic nitrogen was used as the nitrogen target parameter in the original TMDL for Portneuf River (DEQ 2001b). To be consistent, a target of 0.8 mg/L for total inorganic nitrogen is recommended for the Portneuf River. Note: this total inorganic nitrogen target is a change from that recommended in the original TMDL for the Portneuf River (DEQ 2001b) and will be reflected in the TMDL when it is revisited in 2004.

A target concentration of 0.015 mg/L of chlorophyll *a* is recommended for American Falls Reservoir. EPA (2000) Criteria found that reference conditions (based on the 25th percentile of evaluated waterbodies) for chlorophyll *a* ranged from 0 to 0.0246 mg/L. The 0.015 mg/L target falls closer to the middle of this range, although EPA did note 0.0246 mg/L appeared to be "inordinately high". Oregon uses a criterion of 0.015 mg/L of chlorophyll *a* (based on an average of a minimum three samples collected over any three consecutive months at a minimum of one representative location) to identify waterbodies where phytoplankton may impair recognized beneficial uses, and the value was recommended in the Snake River-Hells Canyon TMDL (IDEQ and ODEQ 2001). For American Falls Reservoir, this target is an average concentration of at least two samples per month at three sites (lower, mid, and upper reservoir) for July and August.

Sediment

Sediment is a problem throughout American Falls Subbasin. Only Knox Creek, where it may also be a problem, is not listed for sediment. Except for Bannock Creek watershed, an average concentration not to exceed 60 mg/L of suspended sediment over a 14-day period is recommended for waterbodies in American Falls Subbasin listed for sediment problems. This target concentration falls within the range, 25-80 mg/L, of suspended solids recommended by the European Inland Fisheries Advisory Commission (EIFAC 1964) for maintaining good to moderate fisheries.

In addition to the EIFAC (1964) report, which linked excess sedimentation to use impairment, the 60 mg/L suspended sediment target is in line with other “local” standards and targets. Nevada (NDEP Web site) has state standards for suspended solids in rivers and creeks that range from 25 to 80 mg/L. Joy and Patterson (1997) set targets at 56 mg/L in tributaries and return drains in the Yakima River in Washington for TSS. In Bear River in Utah, TSS targets were 35 mg/L for smaller streams and 90 mg/L for larger streams (Ecosystem Research Institute 1995). DEQ has established seasonal targets of 50 mg/L and 80 mg/L for TSS in several subbasins (Boise River [Division of Environmental Quality 1999], Portneuf River [DEQ 2001b], Blackfoot River [DEQ 2001c]).

Bannock Creek is not included in this target because the paucity of long-term biological, chemical, and physical data on Bannock Creek and its tributaries hampers any attempt at developing numeric translators that reflect representative water quality conditions and appropriate uses. As is the case with the development of all water quality standards or numeric translators, significant amounts of waterbody-specific data are desired to adequately reflect background, historical, and current biological, chemical, and physical conditions of the waterbody. The more data available, the more accurately water quality criteria and designated uses can be linked and designed to reflect site-specific water quality conditions and seasonal variation. Therefore, to establish surrogates for sediment in Bannock Creek watershed, it is necessary to utilize water quality targets established by DEQ for similar streams in Idaho where more site-specific data are available.

As such, sediment TMDLs for Bannock Creek and its tributaries (West Fork, Moonshine Creek, Rattlesnake Creek) will focus on use of stream bank stability as the qualitative goal for restoring coldwater aquatic life use. Stream bank erosion reductions can be quantitatively linked to sediment reduction. Other DEQ TMDLs (e.g., Little Lost River [DEQ 2000b], Blackfoot River [DEQ 2001c], Palisades [DEQ 2001d]) established a stream bank stability of 80% as an acceptable target, which was believed sufficient to support beneficial uses including coldwater aquatic life and salmonid spawning. Bannock Creek watershed is sufficiently similar to these subbasins to justify use of an 80% stream bank stability target. Bannock Creek is in the same ecoregion (Northern Basin and Range) as Blackfoot River and borders the Middle Rockies Ecoregion of Little Lost River and Palisades subbasins. Geology, soils, and climates are generally similar between the two ecoregions (EPA et al. 2000). An inferential link is identified to show how sediment load allocations will reduce subsurface fine sediment to or below target levels. This link assumes that reducing chronic sources of sediment will decrease subsurface fine sediment and ultimately restore beneficial uses.

Stream bank stability estimates for Bannock and Rattlesnake creeks were derived from DEQ BURP data collected in June 1996 and July 2001. Table 1-7 indicates Bannock Creek mainstem had an average bank stability of 80%. This average was derived from BURP data that represented a portion of Bannock Creek outside of Fort Hall Indian Reservation. Rattlesnake Creek, which has had historical erosion problems, has 34% average bank stability. No bank stability data were available for West Fork and Moonshine Creek.

While limited data exists on stream bank stability conditions of Bannock, Rattlesnake, and Moonshine creeks, field reconnaissance evaluations of West Fork indicate stream bank stability exceeds 80%. These improved conditions in West Fork are the result of careful management of this subwatershed over the past four years, specifically through the installation of fencing along the riparian corridor. These high quality habitat conditions are also substantiated by the low levels of TSS in West Fork estimated from model analysis. Therefore, the 80% stream bank stability and 31.11 mg/L TSS concentrations associated with West Fork provide suitable reference conditions from which to calculate TMDLs for sediment in the Bannock Creek watershed. Despite the fact that West Fork is on the 303(d) list, the significant improvement in water and habitat quality warrants consideration of West Fork as a viable target for gaging the level of improvement necessary in other 303(d) listed waterbodies within Bannock Creek watershed. The TMDL calculations for Bannock Creek watershed assume an acceptable correlation exists between stream bank stability and instream TSS concentrations. The combination of these two surrogates provides reasonable measures from which sediment loading can be evaluated to achieve the prescribed reductions.

Point sources

Recommended targets for point sources followed those for nonpoint sources, or were based on the operator's NPDES permit, whichever was the more restrictive target. For example, permit requirements for suspended solids at Aberdeen and Blackfoot WWTPs are monthly average of 30 mg/L and weekly average of 45 mg/L. Permit requirements for Firth and Shelley were monthly average of 45 mg/L and weekly average of 65 mg/L. The monthly average concentrations were used to estimate target loads at the WWTPs. Current sediment or suspended solids limits for Crystal Springs Trout Farm were not available, so the 14-day average of 60 mg/L was used. No point source had total nitrogen or total phosphorus limits in their NPDES permit, so recommended targets of 0.05 mg/L of total phosphorus and 0.85 mg/L of total nitrogen were applied where applicable. Blackfoot WWTP has a specific ammonia limit, but all the facilities are subject to state water quality standards for un-ionized ammonia, which is toxic to aquatic life.

Margin of Safety

To account for uncertainty associated with insufficient data, and the relationship between pollutant loads and beneficial use impairment, a margin of safety (MOS) is included in development of load analyses. There are several ways to implement a margin of safety. For American Falls Subbasin, it was decided to choose conservative targets, which convey an inherent margin of safety when estimating load and wasteload allocations. The assumption was made that whenever targets were based on NPDES permits, requirements in the permit already included a margin of safety.

The MOS factored into load allocations for Bannock Creek watershed is implicit. Conservative assumptions made as part of the sediment loading analysis include: 1) desired bank erosion rates are representative of background conditions of 80% stream bank stability; 2) the Generalized Watershed Loading Functions (GWLF) modeling effort utilized transport and chemical parameters obtained by general procedures described in the GWLF manual. These procedures are conservative in nature as illustrated by the following:

- The GWLF model describes nonpoint sources with a distributed model for runoff, erosion and urban wash off, and a lumped parameter linear reservoir groundwater model.
- Water balances are computed from daily weather data but flow routing is not considered. Hence, daily values are summed to provide monthly estimates of streamflow, sediment, and nutrient fluxes.
- All precipitation is assumed to exit the watershed in evapotranspiration or streamflow; assuming the rate constant for deep seepage loss is zero.
- During periods of streamflow recession, it is assumed that runoff is negligible, and hence streamflow consists of groundwater discharge.
- Nutrient losses from plant cover are assumed to be 75% of the nutrient uptake of plants.
- Sediment transport capacity is proportional to runoff to the 5/3 power.
- Conservative Curve Numbers are selected by soil type and land use.

Monitoring Points

The objectives of a monitoring effort are to demonstrate long-term recovery, better understand natural variability, track implementation of projects and best management practices (BMPs) once they are developed, and oversee effectiveness of TMDL implementation. This monitoring and feedback mechanism is a major component of the "reasonable assurance of implementation" for the TMDL implementation plan. To the extent possible, DEQ, Shoshone-Bannock Tribes, BOR, and others will collaborate to define data quality objectives that will guide monitoring throughout implementation of American Falls Subbasin TMDLs. Some of these watershed monitoring objectives will include the following:

- Evaluate watershed pollutant sources
- Refine baseline conditions and pollutant loading
- Evaluate trends in water quality data
- Evaluate the collective effectiveness of implementation actions in reducing sediment and nutrient loading to the reservoir, river, and/or tributaries
- Gather information and fill data gaps to more accurately determine pollutant loading

American Falls Reservoir

Monitoring within the reservoir should include the following:

- Documentation of the limiting nutrient(s) to the plankton community
- Bathymetric work for use in a reservoir model
- Identification of a reservoir model
- Collection of appropriate data to run the chosen model

Point sources

Data do not indicate that point sources (i.e., Blackfoot, Firth, and Shelley WWTPs) discharging into Snake River are adversely affecting water quality. However, sampling sites are not immediately downstream of WWTP discharge points. Monitoring of Snake River within a short distance below the discharge points would verify any effect of WWTPs on water quality in the river.

Bannock Creek

Downstream and upstream monitoring sites in each subwatershed should be established and used to determine total loading into Bannock Creek. Load capacity can then be estimated by calculating monthly loading at each downstream site. Upstream sites may be used to determine natural background loads, and any loading contributions from livestock grazing and dirt roads. Seasonal loads may be used to more accurately characterize loading variations and allocate reductions accordingly.

Monitoring parameters should include instream water column TSS, stream substrate fine sediment (depth fines), flow, sinuosity, width:depth and pool:riffle ratios, and stream bank erosion rates. Documentation of the limiting nutrient(s) to the algal community should be considered. In all streams, continued monitoring is necessary to ensure that characterization of these watersheds is complete; guarantee that appropriate BMPs (once developed) are used; and quantify BMP efficiency as sediment and nutrient reductions are made. Moreover, the TMDL process is iterative to assure refinements to management strategies can be made as needed.

5.2 Load Capacity, Estimates of Existing Pollutant Loads, Load Allocation

Load analyses were developed for nutrients and sediment. Nutrient and sediment analyses were done for Snake River, Bannock Creek, and other tributaries, springs, and drains. A chlorophyll *a* target was recommended for American Falls Reservoir. Concomitant with attaining the chlorophyll *a* target is the assumption that dissolved oxygen water quality standards will be met. Wasteload analyses were completed for point sources. Several models were used to assist in load analyses.

Models

American Falls Reservoir

To evaluate the effects of phosphorus loading on phytoplankton and dissolved oxygen, a model was developed for American Falls Reservoir by Ben Cope of EPA. Based on a similar model used on Winchester Lake, Idaho and developed using STELLA software, the model is a one-dimensional (two cells in the vertical) dynamic framework, including modules for heat budgets, phosphorus cycling, phytoplankton kinetics, and dissolved oxygen (Cope 2004a). Data sources for parameters used in the model include DEQ, BOR, USGS, and National Weather Service.

Most models, however, have incomplete data and require certain assumptions in the analyses. There were several data gaps associated with the American Falls Reservoir model (these are listed in Table 5-1), and the following assumptions were necessary to run the model:

- Each layer (top and bottom) is a completely mixed volume. (The model assumes slight vertical stratification.)
- There is a single phytoplankton community (blue-green algae).
- There is no wind mixing (general mixing is captured in the diffusion coefficient).
- The temperature/density gradient occurs at 5-meter depth.
- There is no phosphorus loading from sediments.

The model was developed using 2001 observations of the system. Conditions were modeled for 1997, 1999, and 2001. The years were considered high-, mid high-, and low-flow years, respectively. For example, percentile rank for mean annual flow (1911-2001) at Snake River near Blackfoot (Ferry Butte) for these calendar years (Figure 2-5) showed rankings of 1.00 for 1997, 0.83 for 1999, and 0.02 for 2001. In other words, 1997 had the highest calendar year flow on record; only 17% of the years had a higher flow than 1999; and, only 2% of the years had a lower flow than 2001. For all calendar year flows from 1970 to 2001, 1997 was still the highest flow while 2001 was the lowest. Flow in 1999 was in the 68th percentile.

Generally, the model predicts observed patterns of water quality in American Falls Reservoir for June through early August. Several conclusions resulted from the modeling effort.

- The American Falls water quality model provides useful information for assessment of water quality dynamics in the reservoir as a whole, despite the observed heterogeneity in water quality across sampling locations. The model parameters estimated for 2001 resulted in reasonable estimates for chlorophyll, temperature, and dissolved oxygen in 2001 and 1968 (modeled because of high phosphorus concentrations observed in Snake and Portneuf rivers) during the July/August period of interest.
- Observations and simulations suggest that release of phosphorus from sediments is a significant source of phosphorus to the system during periods of stratification in July and August.

Table 5-1. American Falls Reservoir model data gaps.

Parameter(s)	Problem	Model Assumptions or Estimation	Comments
water quality profiles in reservoir	no information prior to May or after early August	none	cannot evaluate simulations of spring or late summer conditions
Snake inflows of phosphorus	2001 sampling focused on summer months	interpolation used in winter/spring; constant values assumed in fall	simulated orthophosphate in reservoir suggest that inputs are reasonable
Portneuf inflows of phosphorus	no sampling in 2001; grab sampling over long term	long term average used	does not account for long term changes in average phosphorus
groundwater & ungauged tributary phosphorus	very limited or no sampling	assumed equal to Snake River levels	higher levels known to exist in Portneuf - this is addressed by data at Tyhee gauge
groundwater flows	no sampling	constant value assumed and water balance checked for 1999 and 2001	constant value (2285 cfs) resulted in good water balance
Portneuf flows at mouth	Tyhee gauge not operated in 1997 and 1999	constant value added to Pocatello flows; checked years when both gauges operated	constant value (215 cfs) resulted in reasonable agreement at Tyhee

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- A spring diatom bloom and subsequent settling may be contributing to diminished oxygen levels at depth during periods of stratification, thus contributing to release of orthophosphate from sediments.
- Portneuf River and a number of ungaged tributaries carry relatively high loadings of orthophosphate and total phosphorus to the reservoir, at times exceeding the loading from Snake River in a low water year (2001).
- Simulations suggest that, with zero phosphorus release from sediments and consumption of surplus orthophosphate in late July, phosphorus loadings from the tributaries would be sufficient to drive measurable productivity for the remainder of the summer and fall.
- Model simulations indicate periods of low flow (low water supply) and reservoir elevation (e.g., 2001) may not represent worst-case conditions for water quality in the reservoir.

Snake River

The Simple Method model was used to estimate stormwater runoff for the City of Blackfoot (Appendix D). Stormwater from an estimated 485 acres in the City of Blackfoot drains to Snake River. Annual precipitation was 10.0 inches (25.4 cm) annually (Table 1-1). Loads were estimated for total phosphorus, nitrate+nitrite, and total suspended solids using event mean concentrations from data collected locally (Table 2-10).

Bannock Creek

Existing nonpoint source loads were estimated using the Generalized Watershed Loading Functions (GWLF) model. The model estimates dissolved and total nitrogen and phosphorus loads in surface runoff from complex watersheds. Both surface runoff and groundwater sources are included, as well as nutrient loads from point and nonpoint sources and on-site wastewater disposal (septic) systems. Nutrient loads from septic systems were not modeled due to lack of data.

The GWLF model requires daily precipitation and temperature data, runoff sources and transport, and chemical parameters. Transport parameters include areas, runoff curve numbers for antecedent moisture condition II, and the erosion product KLSCP (Universal Soil Loss Equation parameters) for each runoff source. Required watershed transport parameters are groundwater recession and seepage coefficients, available water capacity of the unsaturated zone, sediment delivery ratio, monthly values for evapotranspiration cover factors, average daylight hours, growing season indicators, and rainfall erosivity coefficients. Initial values must also be specified for unsaturated and shallow saturated zones, snow cover, and 5-day antecedent rainfall plus snowmelt.

Input nutrient data for rural source areas are dissolved nitrogen and phosphorus concentrations in runoff and solid-phase nutrient concentrations in sediment. Daily nutrient accumulation rates are required for each urban land use. Remaining nutrient data are dissolved nitrogen and phosphorus concentrations in groundwater.

For modeling purposes, Bannock Creek watershed was divided into subwatersheds: West Fork, Moonshine, Rattlesnake, and the remaining watershed (including Knox Creek). The model was run for each subwatershed separately using a five-year period, January 1998 - December 2002, and first year results were ignored to eliminate effects of arbitrary initial conditions. Daily precipitation and temperature records for the period were obtained from the Western Regional Climate Center (Web site c). All transport and chemical parameters were obtained by general procedures described in the GWLF manual (Haith et al. 1996), and values used in the model are in Appendix F. Parameters needed for land use were provided by DEQ, and those for soils were obtained from the State Soil Geographic (STATSGO) Database compiled by Natural Resources Conservation Service (NRCS). Figures 5-1 and 5-2 show land use and soils distributions within the watershed. For each land use area, NRCS Curve Number (CN), length (L), and gradient of the slope (S) were estimated from intersected electronic geographic information systems (GIS) land use and soil type layers. Soil erodibility factors (K_k) were obtained from the STATSGO database. Cover factors (C) were selected from tables provided in the GWLF manual (Haith et al. 1996). Supporting practice factors of P = 1 were used for all source areas for lack of detailed data. Area-weighted CN and K_k, $(LS)_k$, C_k, and P_k values were calculated for each land use area. Coefficients for daily rainfall erosivity were selected from tables provided in the GWLF manual. Nutrient concentrations and accumulation rates were estimated from tables provided in the GWLF manual. Model inputs variables are listed in Table 5-2.

Bacteria

As discussed previously in Section 2.4, additional *E. coli* data are necessary to assess attainment status of contact recreation in Bannock Creek. A quality assurance project plan will be prepared through a collaborative effort between DEQ and Shoshone-Bannock Tribes to define an effective water quality monitoring approach to be implemented in 2004. These additional data are necessary to determine if a TMDL for *E. coli* is warranted.

Dissolved oxygen

Of the two waterbodies (Snake River and American Falls Reservoir) listed as having dissolved oxygen concerns, DO appears to be a problem only in the reservoir. The assumption is that control of nutrients and subsequent reduction in algal densities will lead to observance of water quality standards for dissolved oxygen. To help confirm this assumption, dissolved oxygen conditions in the reservoir were modeled under three scenarios of total phosphorus loading: current conditions; future condition when recommended load reductions are met (Table 5-3); and, future condition when recommended load reductions are met, but loads in Snake River increase to the target concentration of 0.05 mg/L of total phosphorus. Model results (Cope 2004b) show virtually no difference amongst the three scenarios in dissolved oxygen levels in the upper 5-meter layer in the reservoir (Table 5-4). A change (increased concentration of over 1 mg/L of dissolved oxygen) is observed under average and high flow conditions in the bottom 5 meters of water under both future condition scenarios.

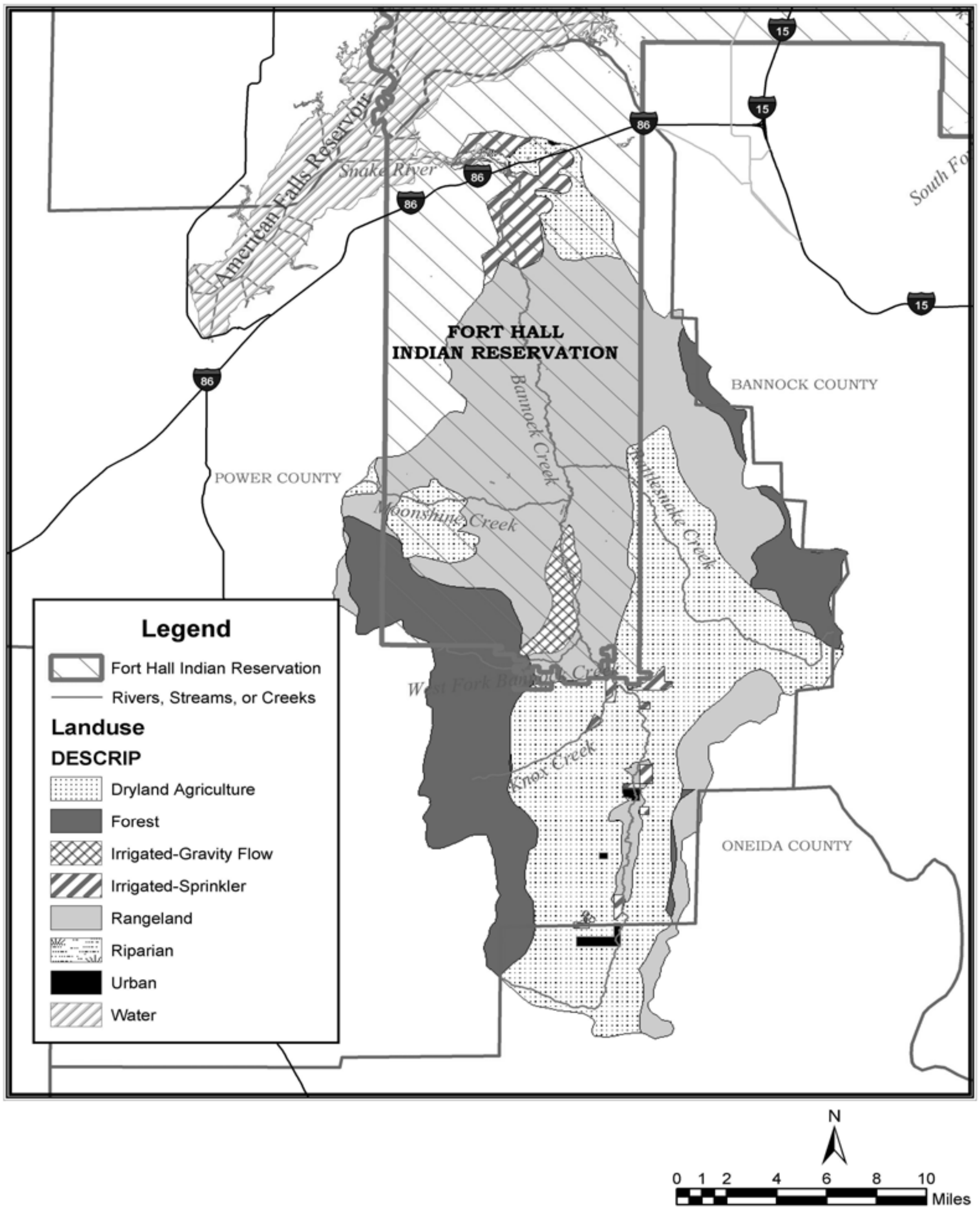

Figure 5-1. Bannock Creek watershed land use.

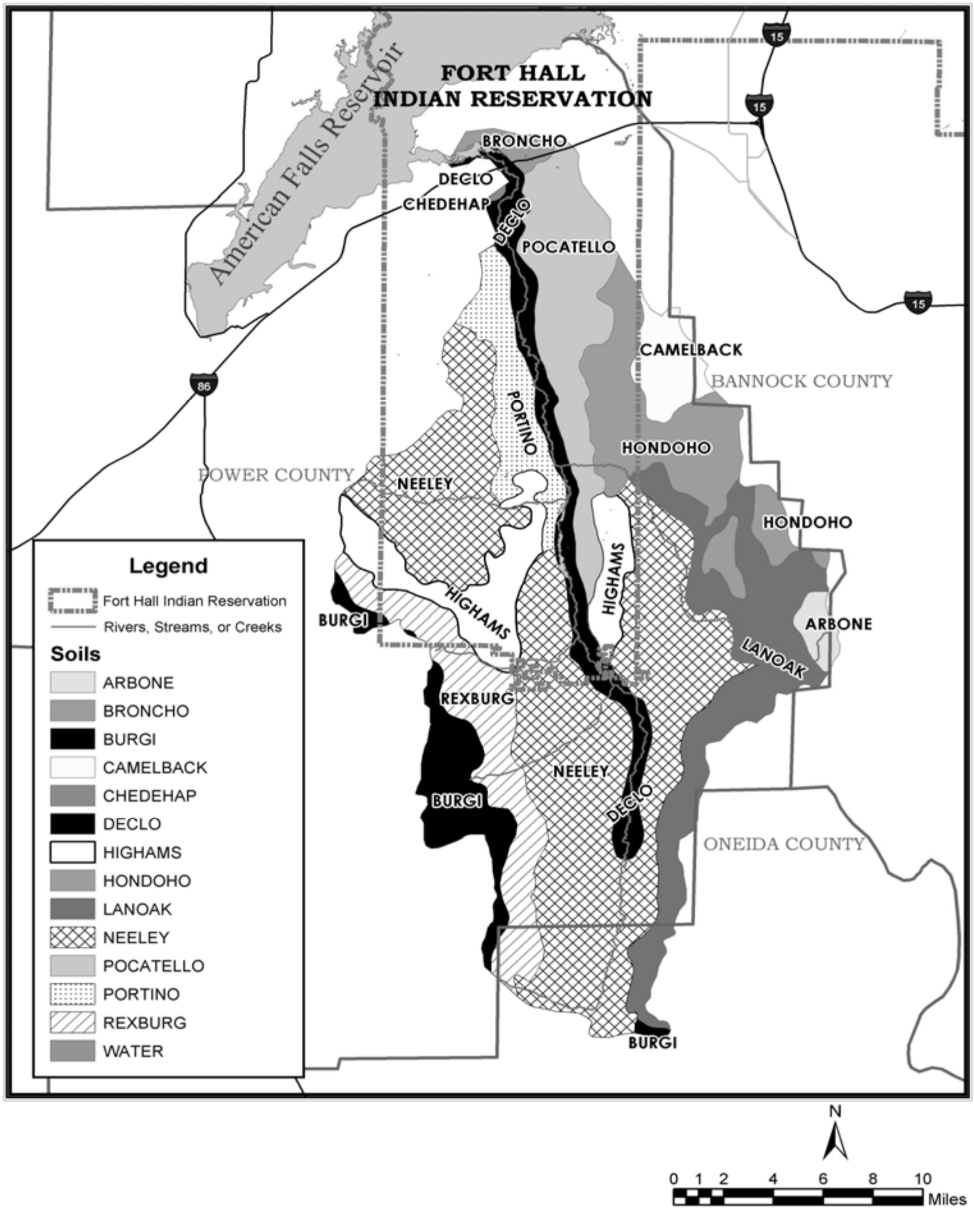

Figure 5-2. Bannock Creek watershed soil.

Table 5-2. Bannock Creek watershed modeling input variables and outputs.

Waterbody	Drainage area (hectare)	Streamflow (cm)	Streamflow (m^3)	TN (mg)	TN (mg/L)	TP (mg)	TP (mg/L)	Sediment (mg)	Sediment (mg/L)	Sediment (tons)	Sediment load capacity (tons)	Percent reduction
West Fork	3,901	4.12	1,607,212	1.4	0.87	0.18	0.11	50	31.11	55.1	55.1	0
Knox Creek	6,038	4.18	2,523,884	2.18	0.86	0.03	0.01	90	35.66	99.2	86.6	12.8
Moonshine Creek	11,680	4.2	4,905,600	4.3	0.88	0.6	0.12	350	71.35	385.8	168.2	56.4
Rattlesnake Creek	21,054	4.25	8,947,950	7.3	0.82	1.05	0.12	575	64.26	633.8	306.9	51.6
Bannock Creek	64,290	4.3	27,644,700 [1]	40.3	1.46	4.08	0.15	950	34.36	1047.2	948.0	9.5
Total	106,963		45,629,346		1.22		0.13		44.16	2,221.157		

[1]average flow at mouth = 51.1 cfs

Table 5-3. TMDL target concentrations for total phosphorus based on average flow.

Source	TMDL target load (lbs/year)	Average flow (cfs)	TMDL target concentration (mg/l)
Snake River	334,000	4,800	0.035
Portneuf River	43,500	440	0.05
Smaller creeks, including Bannock Creek	51,000	750	0.035
Groundwater	75,500	1,540	0.025

Notes:
- groundwater values based on assumed TP concentration of 0.025 mg/l
- DEQ has developed a specific target loading for Bannock Creek

Table 5-4. American Falls Reservoir model results for three TMDL scenarios.

Scenario	Minimum depth-averaged dissolved oxygen (mg/L) July through August						Mean chlorophyll *a* concentration (mg/l) July through August		
	Top 5 meters			Bottom 5 meters					
	2001 (low flow year)	1999 (mid-high flow year)	1997 (high flow year)	2001 (low flow year)	1999 (mid-high flow year)	1997 (high flow year)	2001 (low flow year)	1999 (mid-high flow year)	1997 (high flow year)
Existing conditions	6.9	7.0	6.9	6.0	4.2	3.2	0.010	0.034	0.035
Load allocations achieved	6.9	7.0	7.0	6.0	5.1	4.2	0.007	0.014	0.019
Load allocations achieved, Snake River load increased to target TP concentration of 0.05 mg/L	6.9	7.0	6.9	6.0	5.3	4.5	0.008	0.017	0.023

Notes:
- 2001 weather data used for all model simulations
- TMDL simulations assume constant input concentrations of target total phosphorus (Table 5-3)
- existing conditions simulations include time variable, Snake River phosphorus based on 2001 sampling, average concentration for year = 0.027 mg/L
- all simulations assume existing ratios of total phosphorus/ortho-phosphorus
- July/August mean is mean of 62 daily chlorophyll *a* values
- assumes no internal loading
- like flows, reservoir surface elevations generally low in 2001 and high in 1997

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There are few options available to increase dissolved oxygen other than control of aquatic vegetative growth through nutrient input. Until data show otherwise, the working premise for improvement of dissolved oxygen in American Falls Reservoir will be reduction of nutrients loads and concomitant decreases in algal densities.

No data were encountered to indicate that dissolved oxygen was a problem or that water quality standards were being violated in Snake River. Therefore, no TMDL will be written for dissolved oxygen in Snake River.

Nutrients

American Falls Reservoir

Only tributaries, drains, and springs to the reservoir will receive loads; reservoir loads and associated internal recycling will not be addressed at this time. However, a target concentration for chlorophyll *a* is recommended. The assumption is that reduction in nutrient loadings to the reservoir by contributing tributaries, springs, and drains will result in meeting the chlorophyll *a* target concentration of 0.015 mg/L. Meeting an average chlorophyll *a* concentration will in turn be sufficient to support beneficial uses within the reservoir.

The reservoir model was used to predict chlorophyll *a* levels under various scenarios (Cope 2004b). It was assumed that internal loading would eventually be reduced to zero due to phosphorus reductions and resulting improvements to DO concentrations near the bottom. Modeling of existing conditions resulted in a range of chlorophyll *a* from 0.010 mg/L under low flow conditions to 0.035 mg/L under high flow conditions (Table 5-4). If load allocations outlined in this TMDL are met (Table 5-3), then resultant chlorophyll *a* concentrations should meet the target concentration of 0.015 mg/L in both low and mid-high flow years (Table 5-4). During high flow years, the model predicted a concentration of 0.019 mg/L of chlorophyll *a*, slightly higher than the target concentration, but much reduced from existing conditions. Based on modeling results, it is encouraging that target concentrations for chlorophyll *a* will be met in at least 83% of the flow scenarios (1999 mean annual flow was in the 83rd percentile of all flows) if proposed load reductions are met.

Currently, Snake River is below the total phosphorus target concentration of 0.05 mg/L (Table 5-5). To account for future growth and the expectation that phosphorus loading to the river will increase, such a scenario was modeled. The assumptions were that load allocations would be met in all other waterbodies, and the load in Snake River would increase to the target concentration of 0.05 mg/L. Under this growth scenario, the reservoir will meet its target chlorophyll *a* concentration only during low flows (Table 5-4). Thus, effects on the reservoir by any potential significant increase in nutrient loading to Snake River should be considered prior to approval of such discharge.

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Table 5-5. Load analyses for American Falls Subbasin waterbodies.

Site/waterbody	Average flow (cfs)	Total phosphorus Average concentration (mg/L)	Total phosphorus Load (tons/yr)	Total phosphorus Target load (tons/yr)	Total phosphorus Load allocation[2] (tons/yr)	Total phosphorus Load reduction (tons/yr)	Total nitrogen[1] Average concentration (mg/L)	Total nitrogen[1] Load (tons/yr)	Total nitrogen[1] Target load (tons/yr)	Total nitrogen[1] Load allocation[2] (tons/yr)	Total nitrogen[1] Load reduction (tons/yr)	Suspended sediment Average concentration (mg/L)	Suspended sediment Load (tons/yr)	Suspended sediment Target load (tons/yr)	Suspended sediment Load allocation[2] (tons/yr)	Suspended sediment Load reduction (tons/yr)
Snake River																
nr Blackfoot (Ferry Butte) USGS gage	4,840	0.035	167	239	167	0	0.402	1,918	4,057	1,918	0	15.1	72,074	286,385	72,074	0
at Blackfoot USGS gage	5,074	0.029	146	250	146	0	0.330	1,649	4,253	1,649	0	6.9	34,619	300,231	34,619	0
nr Shelley USGS gage	5,954	0.029	171	294	171	0	0.352	2,066	4,991	2,066	0	5.9	34,573	352,301	34,573	0
Portneuf River																
Tyhee USGS gage	NA[3]	1.205/0.810	387	22	22	365	2.628	1,144	348	348	796	49.6	21,602			
Bannock Creek																
Bannock Creek at mouth	51.1	0.13	6.5	2.6	2.6	3.9	1.22	61.5	42.8	42.8	18.7	NA[4]	1,047	948	948	99
West Fork Bannock Creek at mouth												NA[4]	55	55	55	0
Moonshine Creek at mouth												NA[4]	386	168	168	218
Rattlesnake Creek at mouth												NA[4]	634	307	307	327
Other tributaries, springs, and drains																
Clear Creek	37.2	0.029	1.07	1.83	1.07	0.00	1.740	63.80	31.16	31.16	32.64	10.0	365.7			
Danielson Creek	56.2	0.035	1.92	2.77	1.92	0.00	0.970	53.80	47.14	47.14	6.66	11.3	626.7	3,327.6	626.7	0.0
Hazard Creek (Little Hole Draw)	16.7	0.248	4.09	0.82	0.82	3.26	2.852	46.93	13.98	13.98	32.94	9.9	163.6	987.2	163.6	0.0
McTucker Creek	196.2	0.034	6.51	9.68	6.51	0.00	1.200	232.27	164.48	164.48	67.79	7.4	1,438.8	11,610.1	1,438.8	0.0
Seagull Bay tributary	5.4	0.216	1.16	0.27	0.27	0.89	0.811	4.34	4.55	4.34	0.00	138.3	740.3			
Spring Creek	356.6	0.025	8.62	17.58	8.62	0.00	1.112	390.87	298.91	298.91	91.96	8.2	2,897.0			
Sunbeam Creek	4.4	0.246	1.07	0.22	0.22	0.85	0.993	4.32	3.70	3.70	0.62	95.1	413.6	261.1	261.1	152.5
Big Hole	0.7											1.7	1.2			
Cedar spillway	31.1	0.020	0.36	0.90	0.36	0.00	0.235	4.23	15.28	4.23	0.00	10.0	179.8			
Colburn wasteway	5.2	0.056	0.29	0.26	0.26	0.03	1.419	7.33	4.39	4.39	2.94	12.6	65.0			
Crystal springs	49.1	0.048	2.32	2.42	2.32	0.00	2.051	99.26	41.14	41.14	58.12	13.1	635.2			
Nash spill	1.3	0.013	0.009	0.038	0.009	0.00	0.094	0.07	0.64	0.07	0.00	9.5	7.1			
R spill	0.3	0.016	0.003	0.009	0.003	0.00	0.196	0.03	0.15	0.03	0.00	10.6	1.8			
Spring Hollow	5.3	0.142	0.74	0.26	0.26	0.48	9.931	51.88	4.44	4.44	47.44	153.2	800.1			
Sterling wasteway	5.5	0.081	0.44	0.27	0.27	0.17	1.678	9.05	4.59	4.59	4.47	37.2	200.7			

[1]loads calculated for total nitrogen except for Portneuf River where loads calculated for total inorganic nitrogen for consistency with Portneuf River TMDL: Water Body Assessment and Total Maximum Daily Load (DEQ 1999)

[2]where current loads were less than target loads, load allocations were set at current loads based on Idaho Antidegradation Policy

[3]loads at Tyhee USGS gage on Portneuf River based on monthly flows rather than annual average flow

[4]sediment loads in Bannock Creek watershed based on GWLF model

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Snake River

No data were encountered to indicate nutrients were a problem or that water quality standards were being violated in Snake River. However, Snake River is a major contributor of nutrients to American Falls Reservoir. Load allocations for Snake River are recommended at Ferry Butte (Tilden Bridge), Blackfoot, and Shelley (Table 5-5). Annual total phosphorus load allocations are 146 tons at Blackfoot, 167 tons at Ferry Butte, and 171 tons at Shelley. Load allocations for total nitrogen are 1,649, 1,918, and 2,066 tons per year, respectively. These load allocations represent no increase above current loads, thus no load reductions are required.

Because nutrients do not appear to be affecting beneficial uses in Snake River, no nutrient wasteload reductions are recommended for Blackfoot, Firth, and Shelley wastewater treatment plants or for stormwater runoff from City of Blackfoot. Phosphorus wasteload allocations for the three WWTPs are 9.5, 0.5, and 1.3 tons per year of total phosphorus, respectively (Table 5-6). For nitrogen, annual wasteload allocations were set at 55.9 tons for Blackfoot, 3.0 tons for Firth, and 7.2 tons for Shelley. The wasteload allocation for stormwater runoff from City of Blackfoot is set at 0.33 tons per year of total phosphorus (Table 5-7). No data were available for total nitrogen so a load allocation for nitrate+nitrite of 0.10 tons per year was recommended.

Wasteload allocations reflect a no overall increase from current loading. It is likely these areas will see some population growth in the near future. To calculate future growth, population was projected to increase 2% per year. Each additional person was estimated to use 100 gallons of water per day. Current nutrient concentrations were used for the future wasteload estimates. Wasteloads for 10 and 20 years in the future are presented in Table 5-8. Should Blackfoot, Firth, or Shelley see increases in population to these levels, or other increased demands on the WWTP, consideration will be made to revise the TMDL to account for the required new capacity. As mentioned above in the American Falls Reservoir subsection, caution must be used in recommending future wasteload (or load) allocations until potential effects on the reservoir are better understood.

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Table 5-6. Wasteload analyses for point source (wastewater treatment plants and fish hatcheries) dischargers in American Falls Subbasin.

Point source	Average flow (cfs)	Total phosphorus					Total nitrogen					Suspended sediment				
		Average concentration (mg/L)	Wasteload (tons/yr)	Target wasteload (tons/yr)	Wasteload allocation[1] (tons/yr)	Wasteload reduction (tons/yr)	Average concentration (mg/L)	Wasteload (tons/yr)	Target wasteload (tons/yr)	Wasteload allocation[1] (tons/yr)	Wasteload reduction (tons/yr)	Average concentration (mg/L)	Wasteload (tons/yr)	Target wasteload[2] (tons/yr)	Wasteload allocation[1] (tons/yr)	Wasteload reduction (tons/yr)
Aberdeen WWTP	0.65	1.28	0.822	0.032	0.032	0.790	9.58	6.160	0.547	0.547	5.581	11	7.3	19.3	7.3	0.000
Blackfoot WWTP	2.45	3.91	9.463	0.121	9.463	0.000	23.13	55.936	2.055	55.936	0.000	11	26.2	72.5	72.5	0.000
Firth WWTP	0.18	2.75	0.487	0.009	0.487	0.000	16.77	2.969	0.150	2.969	0.000	22	4.0	8.0	8.0	0.000
Shelley WWTP	0.47	2.74	1.282	0.023	1.282	0.000	15.39	7.194	0.397	7.194	0.000	42	19.7	21.0	21.0	0.000
Crystal Springs Trout Farm	62.00	0.02	1.223	3.057	1.223	0.000	0.11	6.726	51.971	6.726	0.000	1	61.1	3,668.6	61.1	0.000

[1]where current wasteloads were less than target wasteloads, wasteload allocations were set at current wasteloads based on Idaho Antidegradation Policy

[2]based on NPDES maximum monthly average concentration limits of 30 mg/L for Aberdeen and Blackfoot, and 45 mg/L for Firth and Shelley; current NPDES required maximum concentration for Crystal Springs Trout Farm unknown so 60 mg/L target concentration used

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Table 5-7. Load analyses for City of Blackfoot stormwater runoff. Estimated loads based on Simple Method model.

Parameter	Load (tons/yr)	Target load (tons/yr)	Load allocation (tons/yr)	Load reduction (tons/yr)
Total phosphorus	0.33	0.02	0.33	0
Total nitrate+nitrite[1]	0.10	NA[2]	0.10	0
Total suspended solids	90	22	22	68

[1]no data available for total nitrogen so nitrate+nitrite used becaus of availability

[2]NA=not applicable as no target was set for nitrate+nitrite

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Table 5-8. Wasteload allocations for total phosphorus and total nitrogen based on change in facilities management plans and growth (2% per year) for wastewater treatment plants (WWTP) in American Falls Subbasin.

WWTP	Current		10 years hence				20 years hence			
	Service area (population estimate as of 1 Jul 02)	Daily flow (gal/day)	Population estimate[1]	Daily flow (gal/day)[2]	Total phosphorus wasteload allocation (tons/yr)	Total nitrogen wasteload allocation (tons/yr)	Population estimate[1]	Daily flow (gal/day)[2]	Total phosphorus wasteload allocation (tons/yr)	Total nitrogen wasteload allocation (tons/yr)
Aberdeen	1,839	421,556	2,242	461,829	0.04	0.60	2,733	510,921	0.04	0.66
Blackfoot[3]	10,552	1,574,356	12,863	1,805,438	2.02	32.68	15,680	2,087,127	2.33	37.78
Firth[4]	838	116,022	1,022	134,374	0.56	3.44	1,245	156,745	0.66	4.01
Shelley	3,838	306,341	4,679	390,392	1.63	9.17	5,703	492,848	2.06	11.57

[1]based on a 2% annual increase in population

[2]future flow calculated as current flow plus 100 gal/capita/day for each additional person

[3]nutrient concentrations of 0.73 mg/L used for TP and 11.86 mg/L used for TN; these figures are average concentrations from Sep 03 to Jan 04 after the new selector basin came on line in Aug 03

[4]includes Basalt

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Bannock Creek

As indicated previously, DEQ has set water quality targets for average concentrations of total nitrogen (TN) and total phosphorus (TP) at 0.85 and 0.05 mg/L, respectively. Table 5-9 illustrates the resultant calculation of the annual average load capacities for Bannock Creek, which are 43 and 2.6 tons of TN and TP, respectively.

Table 5-9. Bannock Creek annual average nitrogen and phosphorus load capacities.

Parameter	Target concentration (mg/L)	Annual average flow (cfs)	Load capacity (tons/yr)
TN	0.85	51	43
TP	0.05	51	2.6

The GWLF model was used to estimate existing annual average concentrations from nonpoint sources in Bannock Creek watershed. Average concentrations were 1.22 mg/L for total nitrogen and 0.13 mg/L for total phosphorus.

Since there are no point source discharges of nutrients in Bannock Creek watershed, calculation of the TMDL only provides a load allocation for nonpoint sources. The load allocation is expressed as a percent reduction in existing loads to correspond to the calculated load capacities. Table 5-10 shows that 30% and 62% reductions of total nitrogen and total phosphorus, respectively, are required to meet water quality target goals for nutrients in Bannock Creek watershed. Table 5-11 expresses nutrients as an annual average load.

Table 5-10. Bannock Creek nitrogen and phosphorus annual average concentrations and percent reduction required.

Parameter	Current annual average concentration (mg/L)	Water quality target (mg/L)	Reduction required
TN	1.22	0.85	30%
TP	0.13	0.05	62%

Table 5-11. Bannock Creek nitrogen and phosphorus annual average loading and percent reduction required.

Parameter	Current average load (tons/year)	Load capacity (tons/year)	Reduction required
TN	61	43	30%
TP	6.5	2.6	62%

Other tributaries

Although no other waterbodies are listed for nutrients on the 303(d) list, load allocations are recommended for tributaries, springs, and drains that directly contribute to nutrient loads in American Falls Reservoir. Reductions in total phosphorus loads are recommended for Hazard Creek/Little Hole Draw, Seagull Bay tributary, Sunbeam Creek, Colburn wasteway, Spring Hollow, and Sterling wasteway (Table 5-5). All phosphorus load reductions are less than 1 ton per year except Hazard Creek/Little Hole Draw, which needs a 3.26 tons per year reduction to meet its load allocation. For nitrogen, all but four of the waterbodies require a load reduction to meet their total nitrogen load allocation. Highest annual load reductions were estimated for Spring Creek (92 tons), McTucker Creek (68 tons), Crystal springs (58 tons), Spring Hollow (47 tons), Hazard Creek/Little Hole Draw (33 tons), and Clear Creek (33 tons).

A major source of phosphorus and nitrogen in American Falls Reservoir is Portneuf River for which a TMDL was completed in 2001 (DEQ 2001b). The City of Pocatello has been monitoring water quality in the river just upstream of the USGS gage at Tyhee since 1999 (Table 5-12). From these data and flows at Tyhee gage, total phosphorus and nitrogen loads from Portneuf River were estimated at 386.5 and 1,144 tons per year, respectively (Table 5-13). Load allocations of 21.8 tons per year for total phosphorus and 348.3 tons per year for total nitrogen necessitate load reductions of 365 and 796 tons per year, respectively (Table 5-5). These Portneuf River load allocations are different than those recommended in the 2001 TMDL when nutrient load allocations necessary to support beneficial uses in American Falls Reservoir were not known. In addition, since the original Portneuf River TMDL was completed, more data have been collected allowing for refinement of pollutant loads in the river. These changes will be reflected in the Portneuf River TMDL when it is revisited in 2004.

The City of Aberdeen’s wastewater treatment plant is a source of nutrients into Hazard Creek/Little Hole Draw, and subsequently American Falls Reservoir. Load reductions for both phosphorus and nitrogen have been recommended for Hazard Creek/Little Hole Draw (Table 5-5). To help meet these nutrient load reductions, wasteload allocations of 0.032 tons per year of total phosphorus (target concentration equals 0.05 mg/L) and 0.547 tons per year of total nitrogen (target concentration equals 0.85 mg/L) have been recommended for Aberdeen WWTP (Table 5-6).

To account for potential future growth in population in Aberdeen, future wasteload allocations were estimated. Population was expected to increase at a 2% annual rate with a 100 gallon per capita usage rate for each new person. Target concentrations were used to estimate the future wasteloads, which are presented in Table 5-8. Should Aberdeen see increases in population to these levels, or other increased demands on the WWTP, consideration will be made to revise the TMDL to account for the required new capacity.

Crystal Springs Trout Farm discharges into a tributary of American Falls Reservoir. Both estimated phosphorus and nitrogen concentrations from the hatchery were below target concentrations of 0.05 and 0.85 mg/L, respectively (Table 5-14). The wasteload allocations of

Table 5-12. City of Pocatello sampling on Portneuf River at Siphon Road, February 1999 to August 2003.

Time period	Statistic	Ortho P (mg/L)	Total P (mg/L)	NH_3 (mg/L)	NO_3+NO_2 (mg/L)	TKN (mg/L)	Total Inorganic N (mg/L)	Total N (mg/L)	TSS (mg/L)
Jan-Dec	Average	1.03	0.96	0.38	2.23	0.90	2.63	3.08	49.62
	Count	48	46	36	46	36	36	36	25
	Standard Deviation	0.61	0.29	0.52	0.43	0.36	0.67	0.50	71.75
	Maximum	3.8	1.59	3.2	2.97	1.8	5.87	4.21	340
	Minimum	0.06	0.2	0.1	0.93	0.5	1.21	2.11	11
	Median	0.95	0.925	0.2	2.275	0.85	2.545	3.02	22
Jun-Sep	Average	1.23	1.20	0.42	2.49	0.76	2.88	3.23	41.86
	Count	19	18	13	18	13	13	13	7
	Standard Deviation	0.77	0.23	0.84	0.44	0.22	1.03	0.46	53.03
	Maximum	3.8	1.59	3.2	2.97	1.1	5.87	3.97	160
	Minimum	0.06	0.52	0.1	1.01	0.5	1.21	2.11	13
	Median	1.3	1.2475	0.2	2.66	0.7	2.81	3.26	17
Oct-May	Average	0.90	0.81	0.36	2.06	0.98	2.48	3.00	52.64
	Count	29	28	23	28	23	23	23	18
	Standard Deviation	0.44	0.22	0.21	0.32	0.40	0.28	0.51	79.00
	Maximum	2.73	1.43	0.8	2.51	1.8	3.21	4.21	340
	Minimum	0.15	0.2	0.1	0.93	0.5	1.85	2.4	11
	Median	0.88	0.81	0.4	2.0875	0.9	2.46	2.84	24

Table 5-13. Load analyses for Portneuf River.

Month	Average flow (cfs)[1]	Total phosphorus			Total inorganic nitrogen		Total suspended solids (TSS)
		Load (tons)	Load by period - Jun-Sep, Oct-May (tons)	Target load (tons)	Load (tons)	Target load (tons)	Load (tons)
January	492.8	39.8	33.4	2.1	108.4	33.0	2,046.7
February	547.1	40.2	33.8	2.1	109.7	33.4	2,070.6
March	648.4	52.3	43.9	2.7	142.6	43.4	2,692.9
April	634.9	49.6	41.6	2.6	135.1	41.1	2,551.8
May	502.3	40.5	34.0	2.1	110.5	33.6	2,086.1
June	258.8	20.2	25.3	1.0	55.1	16.8	1,040.2
July	188.2	15.2	19.0	0.8	41.4	12.6	781.6
August	274.1	22.1	27.6	1.1	60.3	18.4	1,138.4
September	325.6	25.4	31.8	1.3	69.3	21.1	1,308.7
October	440.8	35.6	29.9	1.8	97.0	29.5	1,830.7
November	496.7	38.8	32.6	2.0	105.7	32.2	1,996.3
December	495.4	40.0	33.6	2.1	109.0	33.2	2,057.5
Total (annual)		419.8	386.5	21.8	1,144.0	348.3	21,601.6

[1]for WY1985-2002 (from Brennan et al. 2003)

Table 5-14. Crystal Springs Trout Farm data, from Best Management Practices Plan-Crystal Springs Trout Farm OD-G13-0038 (letter from Brockway Engineering to EPA date 1 Feb 01).

Water source	Flow (cfs)	Total P (mg/L)	Ammonia (mg/L)	NO_3+NO_2 (mg/L)	TKN (mg/L)	Total N (mg/L)	Suspended sediment (mg/L)
Influent	62.00	0.02	0.03	2.20	0.15	2.35	1.00
Effluent	62.00	0.04	0.05	2.21	0.25	2.46	2.00

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1.2 tons per year of total phosphorus and 6.7 tons per year of total nitrogen represent no increase over current expected wasteloads, and thus require no load reductions (Table 5-6).

Sediment

American Falls Reservoir

No data were encountered indicating sediment was a problem or that water quality standards were being violated in the reservoir. Therefore, a TMDL is not necessary for sediment in American Falls Reservoir.

Snake River

Although no data were encountered indicating that sediment was a problem in Snake River, more data are needed during average and high flows, along with a BURP assessment to show status of support of beneficial uses, to confidently conclude sediment is not a problem. Sediment load allocations are therefore set at current loads, representing no overall increase and requiring no load reductions.

Point sources were not a significant source of sediment into Snake River, except possibly for City of Blackfoot stormwater runoff. All three WWTPs – Blackfoot, Firth, and Shelley – had average effluent concentrations of total suspended solids well below the Snake River target concentration of 60 mg/L and their respective NPDES maximum concentration limits (Table 5-6). Wasteload allocations are based on no overall increase of current wasteloads into Snake River. The Simple Method model estimated the City of Blackfoot stormwater runoff was contributing 90 tons per year of sediment into Snake River, well above a target load based on 60 mg/L (Table 5-7, Appendix D). The load allocation for stormwater runoff is set at the target load of 22 tons per year.

Bannock Creek

As indicated in Table 1-7, portions of Bannock Creek are currently achieving the target bank stability criterion of 80%. More importantly, as discussed in Section 5.1 above, the significant improvements in water and habitat quality of West Fork Bannock Creek suggest that aquatic life use in this subwatershed are being attained. Therefore, West Fork Bannock Creek provides an acceptable reference condition from which sediment loading capacity calculations can be derived for other impaired waterbodies in Bannock Creek watershed. Table 5-15 illustrates the resultant calculation of load capacities for sediment in Bannock Creek, West Fork, Moonshine Creek, and Rattlesnake Creek subwatersheds.

Table 5-15. Bannock Creek, West Fork, Moonshine Creek, and Rattlesnake Creek annual sediment load capacities.

Waterbody	Target erosion rate (tons/mile/year)	Creek length (miles)	Load capacity (tons/year)
Bannock Creek	17.9	53.1	948
West Fork	7.8	7.09	55
Moonshine Creek	17.35	9.68	168
Rattlesnake Creek	16.5	18.65	307

Results from GWLF for modeling existing sediment loads from nonpoint sources in Bannock, West Fork, Moonshine and Rattlesnake subwatersheds are shown in Table 5-16.

Table 5-16. Existing annual average sediment loads from nonpoint sources in Bannock Creek, West Fork, Moonshine Creek, and Rattlesnake Creek.

	Bannock Creek	West Fork	Moonshine Creek	Rattlesnake Creek
Average sediment load (tons/yr)	1047	55	386	634

Since there are no point sources of sediment in Bannock Creek watershed, TMDL calculations provide load allocations for nonpoint sources only. Load allocations are expressed as a percent reduction in existing loads to correspond to calculated load capacities. Table 5-17 shows that 9, 0, 56 and 52% reductions in sediment loads are recommended for Bannock, West Fork, Moonshine and Rattlesnake creeks, respectively. Table 5-2 provides a summary of modeling input variables and outputs for sediment that support calculations presented in Tables 5-15, 5-16, and 5-17.

Table 5-17. Bannock Creek, West Fork, Moonshine Creek, and Rattlesnake Creek sediment load allocations.

Waterbody	Existing sediment load (tons/year)	Load capacity (tons/year)	Percent reduction
Bannock Creek	1047	948	9%
West Fork	55	55	0%
Moonshine Creek	386	168	56%
Rattlesnake Creek	634	307	52%

Other tributaries

Although listed as having sediment problems, data indicate that total suspended solids in McTucker Creek averaged 7.4 mg/L, well below the target concentration of 60 mg/L (Table 5-5). Therefore, the sediment load allocation for McTucker Creek is based on a no overall increase of 1,439 tons per year. Such low levels of water column sediment in McTucker Creek point out the need for further work to identify the source of the sediment problem.

Only three tributaries exceeded the 60 mg/L target concentration for sediment (Table 5-5). None of the three waterbodies - Seagull Bay tributary, Spring Hollow, and Sunbeam Creek – are listed on the 303(d) list. As sediment is not impairing beneficial uses in the reservoir, load allocations are not recommended for Seagull Bay tributary and Spring Hollow. Both of these waterbodies should be considered for future monitoring through DEQ's BURP effort.

BURP data indicate impairment of water quality in Sunbeam Creek, Danielson Creek, and Hazard Creek/Little Hole Draw (Table 2-14). In anticipation of a future listing of Sunbeam

Creek on the 303(d) list for non support of beneficial uses, a load allocation of 261 tons per year of sediment is recommended (Table 5-5). This allocation will require an annual load reduction of 153 tons per year. For Danielson Creek and Hazard Creek/Little Hole Draw load allocations are based on current load estimates.

Neither Aberdeen WWTP nor Crystal Springs Trout Farm is a significant source of sediment. Both had average or estimated average TSS concentrations in their effluent well below their NPDES permit maximum concentration limit or the target concentration of 60 mg/L (Table 5-6). Wasteload allocations for these two point sources are based on no overall increase of current loading (Table 5-5).

Temperature

Although not listed as a concern on the 303(d) list, temperature exceedances have been documented in American Falls Reservoir and Snake River. Both of these waterbodies are large enough that violations of state water quality standards for temperature would not be unexpected. More data are needed to determine if these temperature violations are impairing beneficial uses before recommending that the two waterbodies be listed for temperature problems on future 303(d) lists.

Reasonable Assurance

The U. S. Environmental Protection Agency (EPA) requires that Total Maximum Daily Loads (TMDL), with a combination of point and nonpoint sources and with wasteload allocations dependent on nonpoint source controls, provide reasonable assurance that nonpoint source controls will be implemented and effective in achieving the load allocation (EPA 1991). If reasonable assurance that nonpoint source reductions will be achieved is not provided, the entire pollutant load will be assigned to point sources. Nonpoint source reductions listed in the

American Falls Subbasin TMDL will be achieved through state authority within the Idaho Nonpoint Source Management Program.

Section 319 of the Federal Clean Water Act requires each state to submit to EPA a management plan for controlling pollution from nonpoint sources to waters of the state. The plan must: identify programs to achieve implementation of best management practices (BMPs); furnish a schedule containing annual milestones for utilization of program implementation methods; provide certification by the attorney general of the state that adequate authorities exist to execute the plan for implementation of best management practices; and, include a listing of available funding sources for these programs. The current Idaho Nonpoint Source Management Plan has been approved by EPA (December 1999) as meeting the intent of section 319 of the Clean Water Act.

As described in the Idaho Nonpoint Source Management Plan, Idaho Water Quality Standards require that if monitoring indicates water quality standards are not met due to nonpoint source impacts, even with the use of current best management practices, the practices will be evaluated and modified as necessary by the appropriate agencies in accordance with provisions of the Administrative Procedure Act (IDAPA). If necessary, injunctive or other judicial relief may be initiated against the operator of a nonpoint source activity, in accordance with authority of the Director of Environmental Quality provided in Section 39-108, Idaho Code (IDAPA 58.01.02.350). Idaho Water Quality Standards list designated agencies responsible for reviewing and revising nonpoint source BMPs based on water quality monitoring data generated through the state's water quality monitoring program. Designated agencies are: Department of Lands for timber harvest activities, oil and gas exploration and development, and mining activities; Soil Conservation Commission for grazing and agricultural activities; Transportation Department for public road construction; Department of Agriculture for aquaculture; and the Department of Environmental Quality for all other activities (Idaho Code 39-3602). Existing authorities and programs for assuring implementation of BMPs to control nonpoint sources of pollution in Idaho are as follows:

Nonpoint Source 319 Grant Program	State Agricultural Water Quality Program
Wetlands Reserve Program	Resource Conservation and Development
Conservation Reserve Program	Environmental Quality Improvement Program
Idaho Forest Practices Act	Agricultural Pollution Abatement Plan
Stream Channel Protection Act	Water Quality Certification for Dredge and Fill

Idaho Water Quality Standards direct appointed advisory groups to recommend specific actions needed to control point and nonpoint sources affecting water quality limited waterbodies. Upon approval of this TMDL by EPA Region 10, the existing American Falls Watershed Advisory Group (upon their approval to continue as a committee), with the assistance of appropriate local, state, tribal, and federal agencies, will begin formulating specific pollution control actions for achieving water quality targets listed in the American Falls Subbasin Total Maximum Daily Load plan. The plan is scheduled for completion within eighteen months of finalization and approval of the TMDL by EPA.

5.3 Implementation Strategies

Meeting load and wasteload allocations discussed in this TMDL requires implementation of various policies, programs, and projects aimed at improving water quality in American Falls Subbasin. Like the TMDL, the goal of the implementation plan is to reduce pollutant loading to support beneficial uses. DEQ recognizes implementation strategies for TMDLs may need to be modified if monitoring shows that TMDL goals are not being met or if substantial progress is not being made toward achieving those goals. Conversely, should monitoring show beneficial uses are being supported prior to attainment of TMDL targets, less restrictive load and wasteload allocations will be considered.

Any implementation plan will concentrate on reducing nutrients and sediment. For point sources, such as wastewater treatment plants, it is anticipated that future NPDES permits will include recommended reductions in nutrients (i.e., phosphorus and nitrogen). Reduction in pollutant loadings for nonpoint sources will most likely require a mix of policy changes, program initiatives, and implementation of Best Management Practices.

Time Frame

No time frame is proposed for attainment of beneficial uses in American Falls Subbasin as changes in programs and policies and implementation of practices are highly dependent on many factors. Modifications in current agency operations often require amending government policies, which in turn may necessitate some type of legislative action. Once appropriate legislation is passed, diffusion down to the local level, where programs resulting from such policies are determined and carried out, may not be immediate. Implementation of Best Management Practices may not be rapid as on-the-ground projects, in addition to proper planning, require willing landowners and, often, some type of financial help.

Adding to the problem of predicting when beneficial uses might be obtained are the vagaries of nature. For example, streams that maintain high levels of subsurface sediment are dependent on geofluvial processes to mobilize smaller sediment and move it out of the system. Flows required for such mobilization are dependent on precipitation and resultant runoff, neither of which can be predicted with any certainty next year, let alone years in the future.

The reservoir model assumed recommended reductions in nutrient loading would lead to elimination of phosphorus available for recycling in the reservoir. Currently, there is uncertainty as to how much phosphorus is recycled in the reservoir. Equally unknown is the length of time needed to reduce internal recycling of phosphorus once nutrient loads to the reservoir are reduced. Both of these factors will most likely affect any timetable for attainment of beneficial use support in the reservoir.

Despite the challenges listed above, substantial progress is expected within 10 years of the execution of the implementation plan. Development of a proper monitoring plan should allow a statistical evaluation of that progress.

Approach

Idaho Water Quality Standards list designated agencies responsible for reviewing and revising nonpoint source BMPs based on water quality monitoring data generated through the state's water quality monitoring program (Idaho Code 39-3602). Department of Lands is responsible for timber harvest activities, oil and gas exploration and development, and mining activities. Grazing and agricultural aspects of the implementation plan will be written and developed by Soil Conservation Commission. Public road construction activities fall under the auspices of Transportation Department. Department of Agriculture has responsibility for aquaculture. All other activities are under the purview of DEQ.

As new information is gathered, that data may indicate federal lands as a source of nonpoint pollutant loading in the American Falls Subbasin. It is expected that federal agencies will write their own implementation plans as to how they intend to reduce pollutant loading from lands under their jurisdiction.

Point sources will also be asked to write implementation plans on how they will meet TMDL wasteload allocations. In addition, it is expected that any allocations set forth in this TMDL will eventually be incorporated into the point sources' NPDES permits.

Responsible parties

The implementation of a plan to improve water quality in American Falls Subbasin will require the cooperation of many entities. These may include, but not be limited to, the following:

- Tribal Government – Shoshone-Bannock Tribes
- Federal Government – Bureau of Reclamation, Natural Resources Conservation Service, U. S. Forest Service, Bureau of Land Management
- State Government – Departments of Environmental Quality, Lands, Transportation, Fish and Game, and Agriculture, Soil Conservation Commission
- County Government – Power, Bingham, Bannock counties
- Local Government – Cities of American Falls, Aberdeen, Blackfoot, Firth, Shelley
- Quasi-Government – Power and Bingham Soil Conservation districts,
- Irrigation Companies – Aberdeen-Springfield Canal Company
- Fish Hatcheries – Crystal Springs Trout Farm
- Numerous private individuals

Monitoring Strategy

DEQ will monitor BMP implementation through annual reports submitted as part of any implementation program. Due to constraints of money, time, and personnel, DEQ does not expect to directly monitor BMP effectiveness. Funding agencies should include monitoring as part of project funding requests. Tributary monitoring at the affected streams' confluences would help determine watershed BMP effectiveness.

DEQ is responsible for monitoring both mainstem and tributaries for compliance with TMDL allocations and progress toward supporting beneficial uses. The Beneficial Use Reconnaissance Program monitoring will help determine support of beneficial uses for coldwater aquatic life, salmonid spawning, and contact recreation. Ambient water quality monitoring will be dependent on money, time, and personnel available to DEQ. Point sources will be monitored through their Discharge Monitoring Reports submitted monthly to DEQ.

5.4 Conclusions

The data support nutrient and sediment TMDLs for tributaries, springs, and drains into American Falls Reservoir. Load allocations were developed for nonpoint sources (Snake River, Portneuf River, Bannock Creek, several other tributaries, springs, and drains) and wasteload allocations were recommended for point sources (Aberdeen, Blackfoot, Firth, and Shelley WWTPs, Crystal Springs Trout Farm, City of Blackfoot stormwater runoff) for both nutrients and sediment. Reservoir modeling predicts that if the phosphorus load is reduced as recommended, the target level of 0.015 mg/L of chlorophyll *a* will be achieved under all but the highest annual flow conditions. The model also predicts that if target chlorophyll *a* levels are met, dissolved oxygen water quality standards will be met in the top 5 meters and improved in the bottom 5 meters of the reservoir.

Data examined did not indicate nutrients, sediment, or dissolved oxygen is impairing beneficial uses in Snake River itself. However, the river is a tributary to the reservoir, and nutrients and sediment are impairing beneficial uses in the reservoir. Therefore, allocations for Snake River and point sources discharging to it were made based on no increase above current loads and wasteloads, respectively. It will be recommended that Snake River be delisted for nutrients and dissolved oxygen on future 303(d) lists.

The Generalized Watershed Loading Functions (GWLF) model was used to determine nutrient and sediment load allocations for Bannock Creek. Sediment loads were also established for West Fork Bannock Creek, Moonshine Creek, and Rattlesnake Creek. Bacteria data in Bannock Creek were insufficient to ascertain its status. DEQ and Shoshone-Bannock Tribes will cooperate in a study to identify bacteria conditions in the watershed.

Sediment load allocations were recommended for McTucker Creek, Danielson Creek, Hazard Creek/Little Hole Draw, and Sunbeam Creek. The load allocation for McTucker Creek represents no increase above current loading, as data imply that water column sediment is not a problem. More study is needed to identify the source of the sediment problem in McTucker Creek. Danielson Creek, Hazard Creek/Little Hole Draw, and Sunbeam Creek are not listed on the 303(d) list, but analysis of BURP data indicated non support of beneficial uses; load allocations were therefore established.

Exceedances of state water quality standards for temperature were documented in American Falls Reservoir and Snake River. Listing these two waterbodies for temperature should be considered for the next 303(d) list.

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